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Marine Aviation Requirements Study: Summary Report

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Introduction and summary

Background

The Marine Aviation Requirements Study is sponsored by the Assistant Deputy Commandant of the Marine Corps for Aviation and the Deputy Commanding General for Combat Development of the Marine Corps Combat Development Command (MCCDC). This study is intended to identify complete Marine Corps aviation requirements across the spectrum of operations from peacetime through major theater war (MTW). The study addresses two broad questions:

- What aviation support is required for joint and combined MAGTF operations in peacetime, wartime, and combinations thereof?
- How do these fiscally unconstrained air support requirements translate into numbers of aviation systems required?

We divided the study into four parts, which include analysis of requirements in forward presence peacetime operations, and analysis of aviation requirements in MTW, small-scale contingency (SSC), and MEU(SOC) scenarios. Results from these four parts are documented in four individual CNA research memoranda (CRMs) [1-4]. This CRM summarizes those results and examines how the four parts, when viewed together, can help determine overall requirements for aircraft and squadrons in the Marine Corps.

This analysis updates and expands upon an earlier CNA study completed in 1989. This study uses a similar analytical approach, but covers a broader spectrum of operations: it considers the Joint context of future operations, looks ahead to 2015 and beyond, and incorporates changes in future concepts of operations.

After a brief description of our analytical approach, we present a summary of results from the four parts of the study and look at how they combine to help estimate overall aircraft requirements. We then present the study background and the foundations of our analysis. Finally, we present a section on each of the four parts of the study: the peacetime forward presence analysis, MTW, SSC, and MEU scenario analyses.

Summary of our approach and assumptions

We based our peacetime squadron requirements analysis on current deployment and exercise support patterns of active force squadrons. We assumed that these commitments, which define the peacetime operating tempo, will be about the same in the 2015 and beyond time frame.

Our analytical approach for the scenario analyses combines the operational context of the scenarios with aircraft capabilities and Marine Corps operational planning factors to make estimates of peak sortie requirements during the most intense periods of an operation. Peak sortie requirements are determined for each aircraft type and mission included in the six functions of Marine aviation. Using appropriate aircraft sortie rates, availability, and combat attrition rates, the number of aircraft needed are then calculated.

In our analysis, we assume that the CH-46E and CH-53D will have been replaced by the MV-22, the EA-6B by the advanced electronic attack (AEA) aircraft, and the F/A-18A/B/C/Ds and AV-8Bs by the joint strike fighter (JSF). In addition, the UH-1Ns, AH-1Ws, and current KC-130 variants will have been upgraded to the UH-1Y, AH-1Z, and KC-130J models. Today's CH-53Es are the heavy-lift aircraft included in the analysis, although we do an excursion which looks at the benefit of modernizing the CH-53Es. Finally, we assume that the vertical-takeoff-and-landing unmanned aerial vehicle (VTUAV) will have been fielded.

We cannot emphasize too strongly that the requirement numbers determined in this study must be viewed as “nominal,” not precise estimates, even though we show them as point values. Results were driven largely by Marine Air Ground Task Force (MAGTF) planning factors, the scenarios, and numerous related assumptions needed to make the calculations. To this we added analytical underpinning. In addition, we have attempted to present our assumptions and calculations in ways that will easily support the Marine Corps in making any needed “what if” assessments and adjustments when using our analyses to help develop future requirements and make decisions about the required numbers of aircraft.

Summary of results

Peacetime requirements analysis

For the peacetime forward presence analysis, we calculated the number of squadron equivalents required to conduct rotational deployments, by type/model/series (T/M/S) aircraft. We multiplied those squadron-equivalents by a factor of 3 or 4, depending on the T/M/S, to account for the rotation base needed to meet rotational deployment commitments continuously. We then added a number of squadron equivalents that typically are involved in supporting exercises that involve other forces—that is, exercises that are more than just a single squadron’s training evolution.

This analysis determined a range of numbers of squadrons, for each T/M/S, to meet peacetime requirements. We then used the midpoint to estimate peacetime squadron requirements and to combine with the other analyses to estimate the total requirement.

Table 1 summarizes the results of our peacetime squadron requirement analysis. On the left, the table shows the number of squadrons in the active force. Next, under peacetime requirements, it shows our estimate of the number of squadrons required. Finally, the last three columns show how these requirements translate into the future requirement. The table presents a point estimate of the peacetime squadron requirement. We assume that rotary-wing and VMM (MV-22) squadrons will use a 4:1 rotation base, and that fixed-wing squadrons will use a 3:1 rotation. These assumptions are similar to current practice. For example, in a 3:1 rotation cycle, a unit that deploys six months is then back at its home station for 12 months before deploying again.

Table 1. Peacetime forward presence requirements

	Current active squadrons			Peacetime requirement		Future requirement for active squadrons		
Aircraft type	**No. Sqns**	AC/ Sqn	No. AC	**No. Sqns**	No. AC	No. AC	**No. Sqns**	Aircraft type
CH-46E	**15**[a]	12	180	**17**	204	224	**19**	MV-22
CH-53D	**3**	10	30	**2**	20			
CH-53E	**6**	16	96	**6**	96	96	**6**	CH-53E
AH-1W	**6**	18	108	**8**	144	144	**8**	AH-1Z
UH-1N	**6**	9	54	**8**	72	72	**8**	UH-1Y
AV-8B	**7**	16	112	**9**	144	288	**24**	JSF
F/A-18s	**14**	12	168	**12**	144			
EA-6B	**4**	5	20	**4**	20	20	**4**	AEA
KC-130 F/R	**3**	12	36	**3**	36	36	**3**	KC-130J

a. One CH-46 squadron is temporarily configured as a CH-46 training squadron. This squadron will revert to a tactical squadron as MV-22s replace CH-46s and the requirement to train CH-46 pilots decreases.

Note that the CH-46E and CH-53D requirement translates into the requirement for MV-22s. Likewise, the JSF requirement is based on replacing the F/A-18s and AV-8Bs.

We examined different assumptions for translating VMA/VMFA/VMFA(AW) peacetime squadron commitments into future JSF squadron requirements. The JSF squadron requirement reported in table 1 is based on 12-plane JSF squadrons and supporting MEU deployments with an entire JSF squadron. The future MEU aviation combat element (ACE) requirement is on the order of 10 JSF, which would need to be supported by a full squadron.

If the JSF requirement were to be based on the current practice of a 4:1 rotation base as used for the other aircraft T/M/S, the JSF estimate would increase from 24 to 28 squadrons, midpoint between 21 and 34 squadrons.

MTW analysis

The MTW scenario concerns the invasion of a U.S. ally by a hostile nation. Enemy forces have advanced to a point where they have taken up defensive positions in an attempt to hold onto territory taken during their initial attacks. The mission of U.S. forces is to restore pre-invasion borders. Scenario timing accounts for buildup of U.S. forces, a shaping phase involving a Joint air and maritime superiority campaign, and the counter offensive. The MAGTF surge period occurs at the initial phases of the counter offensive.

Tables 2 and 3 summarize the results of our MTW analysis. In table 2, we show the peak sorties flown per day during the surge period of operations and the corresponding number of aircraft needed to fly the missions, and account for aircraft availability and combat attrition. The final column shows how the numbers of aircraft convert to numbers of squadrons. We have assumed 12-plane JSF squadrons throughout our analysis.

The peak numbers of daily sorties required for each aircraft type are determined by analysis of the appropriate missions in the six functions of Marine aviation, and presented in the same format as table 2 for each function and mission type. A breakdown of results to this level of detail is presented for each aircraft type in the later section on the MTW scenario analysis.

Table 2. MTW aircraft/squadron requirements

		Aircraft required to				
Aircraft type	Peak sorties flown per day	Fly missions	Account for availability	Account for attrition	Total	**Number of squadrons**
MV-22	599	188	49	23	260	**21.7**
CH-53E	275	84	38	11	133	**8.3**
AH-1Z	426	133	45	14	192(+48)	**10.7(+2.7)**
UH-1Y	163	53	20	7	80	**8.9**
JSF	765	246	44	18	308	**25.7**
AEA	62	20	6	4	30(+10)	**6.0(+2.0)**
KC-130J	45	23	8	2	33	**2.8**
VTUAV	44	33	n/a[a]	3	36	**n/a**

a. Availability included in assumed mission capability (a system of 3 aerial vehicles provides 12 hours continuous coverage per day).

In table 3, we show numbers of squadrons currently in the active and reserve forces alongside the number of squadrons we estimated are needed in the MTW scenario. It is noted that the MTW scenario requires all of the squadrons in the current active and reserve forces, and in the AH-1Z and AEA cases, significantly more. These are the “deployable” squadrons, and do not include the training squadrons and aircraft that must be bought for pipeline and attrition purposes.

Table 3. Comparing current numbers of squadrons and MTW requirement

Aircraft type	Current squadrons			**MTW requirement (squadrons)**	Aircraft type
	Active	Reserve	Total		
CH-46E	15[a]	2	17	**21.7**	MV-22
CH-53D	3	0	3		
CH-53E	6	2[b]	8	**8.3**	CH-53E
AH-1W	6	2	8	**10.7**	AH-1Z
UH-1N	6	2	8	**8.9**	UH-1Y
AV-8B	7	0	7	**25.7**	JSF
F/A-18s	14	4	18		
EA-6B	4	0	4	**6.0**	AEA
KC-130 F/R	3	2	5	**2.8**	KC-130J

a. One CH-46 squadron is temporarily configured as a CH-46 training squadron. This squadron will revert to a tactical squadron as MV-22s replace CH-46s and the requirement to train CH-46 pilots decreases.

b. Reserve CH-53E squadrons have 8 aircraft per squadron; an active squadron has 16 aircraft.

In our MTW analysis, we include excursions and sensitivity analyses to address some issues that arose during the study. For example, we examined the relative benefit of a modernized CH-53E that can lift light armored vehicles (LAVs) and prime movers for light weight 155-mm Howitzers under the future environment conditions considered in this study. The current CH-53E cannot lift this equipment under the distance and environment conditions required in future operations. We found that a modernized CH-53E will pay enormous dividends in terms of improved tactical flexibility and effectiveness of air assault forces without increasing the numbers of aircraft.

We also performed a sensitivity analysis of our baseline calculations of the close air support requirement for JSF, varying such parameters as the percentage of battlefield targets addressed on each day; the probability of weapons performing and hitting targets as designed; and the level of damage required. The sensitivity analysis showed that our initial results fall somewhere in the middle ground, and, thus, serve as a good baseline estimate.

SSC analysis

The SSC scenario is a peace enforcement operation, based on a similar Dynamic Commitment scenario. The mission takes place on a notional island that is partitioned into two separate countries, separated by a UN-monitored buffer zone. Both countries are supported by larger foreign powers. The scenario begins when one country launches an air strike against a port in the other country. In an effort to stop the conflict from expanding, the United Nations requests NATO support to patrol the buffer zone, as well as enforce a no-fly zone that includes the entire island and a buffer zone of 25 miles. The United States sends forces in support of the NATO mission. Marine Corps forces operating as part of a U.S.-led Joint Task Force include a MEU(SOC), a maritime prepositioned squadron (MPSRON), and a maritime prepositioned force (MPF) MEB.

Table 4 presents the results from our SSC analysis. We show the peak sorties flown per day and the corresponding number of aircraft needed to fly the missions and account for aircraft availability. Because of the peacetime enforcement nature of the scenario, we assumed zero combat attrition when making our estimates of the numbers of aircraft needed. The final column shows how the numbers of aircraft convert to numbers of squadrons.

As with the other scenarios, peak numbers of daily sorties required for each aircraft type are determined by analysis of the missions in the six functions of Marine aviation, and presented in table 2 format for each function and mission type. A breakdown of results to this level of detail is presented for each aircraft type in the section summarizing the SSC scenario analysis.

Table 4. SSC aircraft/squadron requirements

Aircraft type	Peak sorties per day	Aircraft required to: Fly missions	Acct for availability	Total	**Number of squadrons**
MV-22	117	48	12	60	**5.0**
CH-53E	45	20	9	29	**1.8**
AH-1Z	52	21	7	28	**1.6**
UH-1Y	30	10	3	13	**1.4**
JSF	132	37	6	43	**3.6**
AEA	16	5	1	6	**1.2**
KC-130J	14	7	2	9	**0.8**
VTUAV	8	6	n/a	6	**n/a**

MEU ACE analysis

We developed MEU ACE requirements from an analysis of MEU basic missions and in a MEU scenario developed for the Marine Corps. As with the other scenario analyses, we examined MEU ACE missions within the six functions of Marine aviation. A key assumption in our analysis is that the missions MEUs will be required to conduct in 2015 and beyond will be similar to those they currently perform.

Based on our initial look at the aviation requirements for various MEU missions, we felt that the best scenario to examine in detail was a non-combatant evacuation operation (NEO). In addition to being a very likely mission for a MEU, it is one of the most asset intensive. The scenario we examined was taken from the MV-22 Concept of Employment (COE) document [5]. This COE was written with input and direction from the Warfighting Development Integration Division of MCCDC and the Deputy Commandant for Aviation.

Table 5 shows the numbers of aircraft determined in our MEU ACE scenario analysis and compares them with current numbers. Note that current numbers for the MV-22 are filled by CH-46Es, and for JSF by AV-8Bs.

Table 5. MEU ACE aircraft requirements

Aircraft type	Sorties flown	Aircraft required			Current numbers
		Fly missions	Acct for availability	**Total**	
MV-22	37	11	3	**14**	12
CH-53E	12	4	2	**6**	4
AH-1Z	16	4	2	**6**	4
UH-1Y	6	2	1	**3**	2
JSF	18	8	2	**10**	6
KC-130J[a]	n/a	n/a	n/a	**2**	2
VTUAV	n/a	3	n/a	**3**	n/a

a. The MEU's two KC-130 stand-by detachments do not have a role in the NEO scenario. However, they do play an important role in some MEU missions, and should continue to be part of the MEU ACE.

The two-plane detachment of KC-130s assigned to a MEU is not aboard the amphibious ready group with the rest of the MEU. It remains in the continental United States as a stand-by detachment, which can be forward-deployed in support of the MEU, at the commander's discretion. Our NEO scenario did not allow time for use of KC-130s, but their requirement does not go away, based on our examination of the basic mission requirements of a MEU. Also, there are currently no unmanned aerial vehicles in the MEU ACE. The VTUAV system is a new system that will be in the Marine Corps in 2015 and beyond.

Total requirements

Table 6 presents our estimates of total aircraft squadron requirements for the Marine Corps. In this table we show side by side various ways to consider the total requirement. As a bare minimum, enough aircraft are needed to meet peacetime forward presence commitments or MTW requirements, as shown in columns four and five. The numbers in column four are determined by adding the future peacetime requirement from table 1 to the current numbers of reserve squadrons shown in table 3. Our MTW analysis assumed operation an independent MEU, most likely in another theater. The MTW+MEU column (six) reflects this case.

Table 6. Future squadron requirement

Current structure		Future requirement: active plus reserve (deployable) squadrons					
Aircraft type	Active +reserve squadrons	Future aircraft	Peacetime Active + Reserve	MTW	MTW +MEU	Peace-time + SSC	MTW +SSC +MEU
CH-46E	17	MV-22[a]	21	21.7	22.9	26.0	**27.9**
CH-53D	3						
CH-53E	8	CH-53E	8	8.3	8.7	9.8	**10.5**
AH-1W	8	AH-1Z	10	10.7	11.0	11.6	**12.6**
UH-1N	8	UH-1Y	10	8.9	9.2	**11.4**	10.6
AV-8B	7	JSF	28	25.7	26.5	**31.6**	30.1
F/A-18s	18						
EA-6B	4	AEA	4	6.0	6.0	5.2	**7.2**
KC-130 F/R	5	KC-130J	5	2.8	3.0	**5.8**	3.8

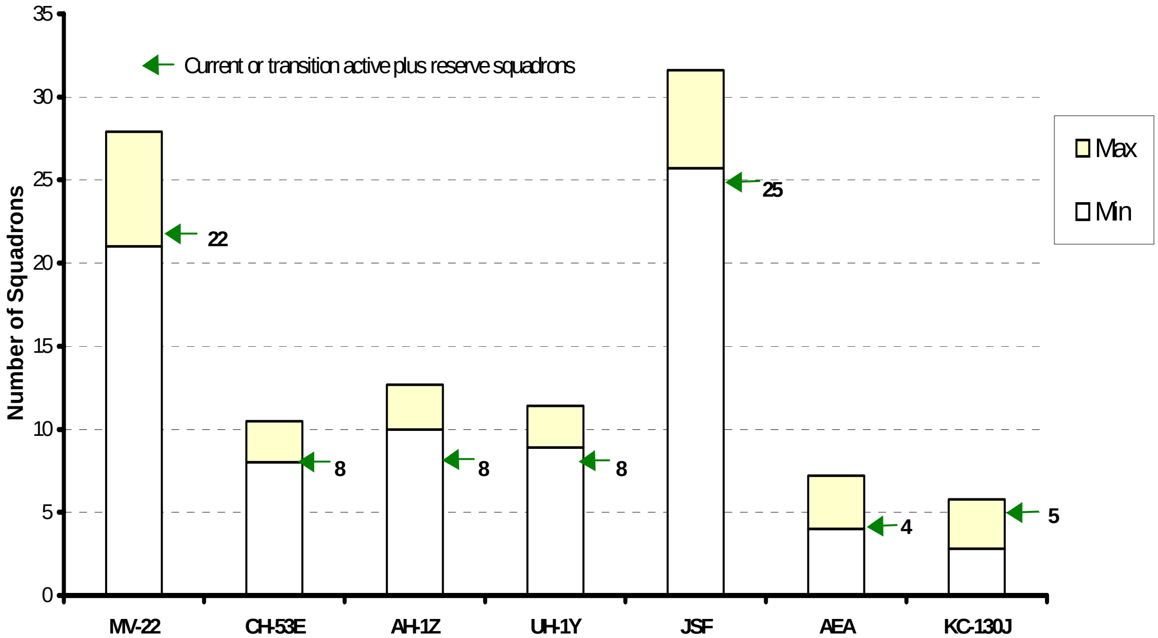
a. Current transition plan is for 18 active and 4 reserve MV-22 squadrons.

In the last two columns we include numbers for Peacetime+SSC and MTW+SSC+MEU. The latter was recommended by the study sponsors as being one of the most reasonable defining requirements. The Peacetime+SSC is a very compelling requirement as well. Many SSCs that come to mind—in particular, the one we analyzed—can be open ended and last a long time. The Marine Corps would want the capability to maintain its peacetime forward presence rotational base while at the same time maintaining support of an SSC.

Generally speaking, the required number of aircraft should, therefore, be the maximum of the categories listed in table 6 for each aircraft type. These are shown in bold and highlighted. In figure 1, we show the range (minimum to maximum) of the requirements presented in table 6 and the current or planned transition numbers of active plus reserve squadrons. This provides another way to view these results. With few exceptions, the current inventory or transition plans include enough squadrons to meet the lower end of the requirement. The AH-1Zs, however, are about two squadrons below the minimum. Although there are enough CH-53E squadrons, they are about a squadron short in numbers of aircraft because the reserve squadrons have 8 instead of the 16 aircraft in an active squadron.

Although not shown in table 6 or figure 1, maintaining a forward presence rotational base and fighting an MTW is probably the most

Figure 1. Range of future squadron requirement



desirable criterion for sizing the Marine Corps aircraft requirement. This would require on the order of double the number of squadrons currently in the active and reserve force, and is probably not a realistic near-term goal. It is, nevertheless, a desirable requirement.

We also need to emphasize that the numbers presented in table 6 and figure 1 are for active plus reserve squadrons, and do not include the associated requirement for training squadrons, pipeline, and peacetime attrition. If new aircraft are to be purchased to meet the requirement, as in the case of MV-22 and JSF, aircraft must also be bought for training, pipeline, and peacetime attrition. For example, the current active and reserve F/A-18 and AV-8B squadrons have a total of 328 aircraft. Applying typical factors for training, pipeline, and attrition produces a required buy of 609 aircraft, which is the current requirement. This is computed assuming 15 percent for training, 15 percent of active plus reserve plus training for pipeline, and two percent of that total over 20 years for peacetime attrition.

Findings and conclusions

Based on our analysis of peacetime forward presence and the MTW, SSC, and MEU scenario analyses, we found that:

- Current and planned transition numbers of aircraft are nearly sufficient to either fight an MTW or maintain peacetime presence, but not both. Even for this, some aircraft are on the low side, particularly the AH-1Z and AEA.
- The maximum MV-22 requirement (peacetime + SSC) is about six squadrons more than the current transition plans for active and reserve squadrons.
- The maximum CH-53E requirement (MTW+SSC+MEU) is about three squadrons more than the current force (accounting for the two reserve squadrons having the same number of aircraft as one active squadron). The important finding for the CH-53E, however, is the need for the modernization program. The CH-53E needs the capability to lift LAVs and LW 155 prime movers to tactically significant distances in the 2015 plus time frame.
- The maximum AH-1Z requirement (MTW+SSC+MEU) and the minimum (peacetime) requirement are both significantly above current inventories and plans (about two to five squadrons). The 1989 study also revealed a shortfall in AH-1s.
- The maximum UH-1Y requirement (peacetime + SSC) is also about three squadrons more than current planned inventory.
- The JSF maximum requirement of 32 squadrons (peacetime + SSC) is seven squadrons more than the numbers of the F/A-18 and AV-8B squadrons. Our requirement for peacetime operations reflects a need for 28 squadrons assuming a 3:1 rotation base and 32 squadrons using a 4:1 base.
- AEA maximum requirements (MTW+SSC+MEU) were determined using the EA-6B ICAPIII aircraft as a surrogate. Our MTW requirement, which calls for 6.0 squadrons, only accounts for the MAGTF requirement. If EA-6B aircraft are

needed to support other forces in theater, then more aircraft will be needed than have been accounted for in this analysis.

- The KC-130 maximum requirement (peacetime + SSC) reflects that these aircraft are fully employed in peacetime. Specific requirements for refueling MV-22s were not included in our scenario analyses. Further analysis with respect to additional demands on the KC-130J as a result of MV-22 will need to be examined, including self-deployment of MV-22s into theater.
- The VTUAV is currently in development, so there is minimal information on which to base a requirement. Perhaps even more than with the other aircraft, our estimates must be viewed as nominal and subject to further analysis.
- Our MEU scenario analysis indicates that another two MV-22, CH-53E, and AH-1Z are needed in the MEU and another four JSF are needed beyond the six AV-8Bs deployed today. A VTUAV system of three AVs is also needed.
- Finally, our aircraft requirement calculations are on the conservative side. We did not calculate the requirement to provide extra sorties to JFACC, and the sortie rates we used may be on the high side. The numbers we used anticipate a higher sortie rate capability in the 2015 plus time frame for the aircraft included in this study. If they perform at rates more in line with historical data, then more aircraft will be needed than our calculations indicate.

Recommendations

Based on our analysis of peacetime forward presence and the MTW, SSC, and MEU scenario analyses, we offer the following recommendations:

- The Marine Corps should pursue the CH-53E modernization program to provide a capability to lift LAVs and LW 155 prime movers in future operating environments
- The AH-1Z was the only aircraft that consistently fell below minimums in our analyses. The Marine Corps needs to consider how to adjust for this shortfall.
- The current transition numbers of squadrons planned for the MV-22 and JSF are six and seven squadrons short, respectively. The Marine Corps should review the planned procurement numbers to ensure that sufficient aircraft will be procured to meet the future requirement.
- Our MEU scenario analysis showed a need for additional aircraft across the board. The Marine Corps should consider ways to make more aircraft available to the MEU.
- And finally, the Marine Corps should use our requirement estimates with a thorough understanding of the underlying assumptions. Although they represent our best estimates, they are nevertheless “nominal” values subject to the various assumptions made. We have attempted to present the requirement estimates in such a way that they can be used and adjusted as necessary to accommodate different circumstances.

The next section presents an overview of the analytical approach used in this study. That will be followed by summary results of the MTW, SSC, and MEU scenarios and the peacetime requirements analysis.

Overview of our analytical approach

Update and expansion of 1989 study

The 1989 CNA *Marine Aviation Requirements Study* [5] formed the foundation of aviation requirements for the Department of the Navy's Integrated Amphibious Operations and USMC Air Support Requirements Study (DoN Lift II), of April 3, 1991[6]. The Marine Corps is interested in an update to the former study for several reasons. There have been changes in the Marine Corps' war fighting concepts and modernization strategy over the ten years since CNA's last Marine Corps aviation requirements study. CNA is scheduled to conduct an analysis to update portions of DoN Lift II, and this examination of aviation requirements will directly complement that effort. Additionally the development of the concepts surrounding such major new systems as the LHA(R) and MPF(F) will require accurately projected USMC aviation requirements. Likewise, service concepts and aviation requirements will be required for the forthcoming Quadrennial Defense Review (QDR). For these reasons, the analysis in the current study is designed to update and expand upon the earlier Marine Aviation Requirements Study.

While the present study is intended to update the 1989 aviation requirements study, and to an extent has taken that analysis as a starting point, there are significant differences between the two efforts. Table 7 provides a brief comparison between the 1989 study and this study.

Table 7. 1989 and current study comparison

1989 CNA study	This study
Foundation for aviation portion of DoN Lift II (1990)	Overlaps with DoN Lift II update analysis
Examined mid-1990s wartime requirements for a MEF/MEB operating ashore	2015 plus timeframe, day-to-day demands to contingencies to wartime
Focused purely on Marine aviation support for the MAGTF	Address Marine aviation support in a combined/joint/MAGTF context

The 1989 CNA study formed the foundation for the aviation portion of DON Lift II. It looked at wartime aviation requirements for a Marine Expeditionary Force (MEF) and a Marine Expeditionary Brigade (MEB) ashore in a medium intensity threat in the mid-1990s. The analysis was built around the following mission categories:

- Deep air support (DAS)
- Close air support (CAS)
- Tactical air transport (Air Assault)
- Anti-air warfare (AAW)
- Additional missions
  - Airborne reconnaissance (AR)
  - Tactical air coordinator airborne (TAC(A))
  - Forward air controller airborne (FAC(A))
  - Suppression of enemy air defenses (SEAD)
  - Electronic warfare (EW)
  - Airborne refueling support, and others

These mission areas covered the six functions of Marine aviation and defined the daily sortie requirements for the Aviation Combat Element (ACE) for a MEF/MEB-level operation ashore. Except for an excursion that studied the impact of receiving direct-support Navy sorties, the previous study focused solely on Marine aviation.

In contrast, the present study is examining Marine aviation support requirements across the spectrum of possibilities, from peacetime operations through contingencies to MTW. We also examine the engaged MAGTF in the broader joint/combined context, to include the build-up of requirements in the halt phase of a major contingency, prior to the friendly offensive. An additional distinction involves the fact that Marine aircraft in 2015 and beyond will differ significantly from those considered in the 1989 study, and the concepts of employment these new aircraft enable are significantly different as well.

Guidance from “Blue Team”

We began this study by forming a “Blue Team” of advisors and subject matter experts (SMEs), primarily representing Headquarters, Marine Corps (HQMC), MCCDC, and the Marine Corps Intelligence Activity (MCIA). The Blue Team played a major role in developing the concepts of operations and relevant assumptions for the scenarios. This team assisted in the gathering of aircraft and system capabilities information, and the development of planning factors and assumptions being applied in the study. They also provided invaluable feedback throughout the analysis, and especially during periodic progress reviews.

Scenario-based analyses

Major steps

We built on our initial fact finding with scenario-based analyses using the following steps:

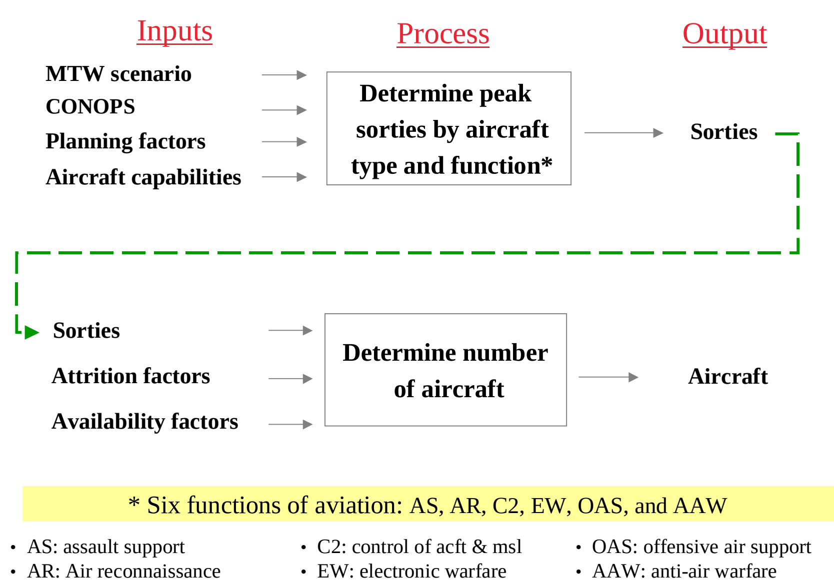
- Develop scenarios and associated concepts of operations (CONOPs).
- Determine planning factors and agree on assumptions.
- Determine capabilities of Marine aircraft.
- Calculate sortie and aircraft requirements.

- Perform excursions/sensitivity analyses to define the probable range of requirements.

Process

Figure 2 is an outline of the basic analytical process we use to combine scenarios, aircraft capabilities, and MAGTF planning factors and assumptions to determine Marine Corps aircraft support requirements. Our basic analytical approach is from the perspective of operational and tactical planners.

Figure 2. Analytical process



The scenarios provide a broad operational context within which planners can bring the individual Marine aircraft capabilities and their associated CONOPS to bear in meeting MAGTF and Joint/Combined objectives. The scenario provides target lists, mission objectives, geometry, timing, threat numbers, threat capabilities, and the general context in which the operational and tactical planning takes place.

The aircraft capabilities and associated concepts of operations for USMC aircraft are other inputs needed in order to apply appropriate MAGTF planning factors and assumptions. These include such factors as range / payload curves for the assault support aircraft, turnaround times in landing zones (LZs) and on ships, sortie rates, aircraft availability, combat attrition rates, nominal weapon loads, and weaponeering capabilities of the aircraft.

The scenarios and aircraft capabilities taken together with the MAGTF planning factors and appropriate operational and tactical assumptions are then used to derive the peak requirements for aviation sorties. Peak sorties are determined in all missions in the six functions of Marine aviation.

The numbers of aircraft required are then determined by accounting for the appropriate sortie rates, availability, and combat attrition factors as outlined in figure 3. We divide the peak number of sorties by the appropriate aircraft sortie rate to determine the number of “up” aircraft needed to fly the missions. This number is then divided by the mission capable rate (availability) to account for (essentially add in) the number of aircraft that would be “down” on a given day. This is the number of aircraft needed if there is no combat attrition. To this number, we add the expected number of combat losses to get the total number of aircraft that are needed. Because the post-surge sortie rate is generally less than the surge rate, the number of aircraft determined is sufficient throughout the campaign.

Table 8 provides the aircraft availability, sortie rates, and attrition factors that we used in our computations. MV-22 availability is assumed to be 80 percent, slightly less than the 82 percent specified in the operational requirements document (ORD). Future new aircraft (JSF and AEA) are assumed to have an availability of 85 percent. For the CH-53E, we used today's values, which were taken from the MAGTF Staff Training Program (MSTP) MEF Planners Reference Manual. The AH-1Z, UH-1Y, and KC-130J are assumed to be somewhat better than today's aircraft, but are not up to new-design aircraft. Availability for the VTUAV is incorporated in its ORD in terms of specifications for continuous daily coverage.

Figure 3. Determining number of aircraft

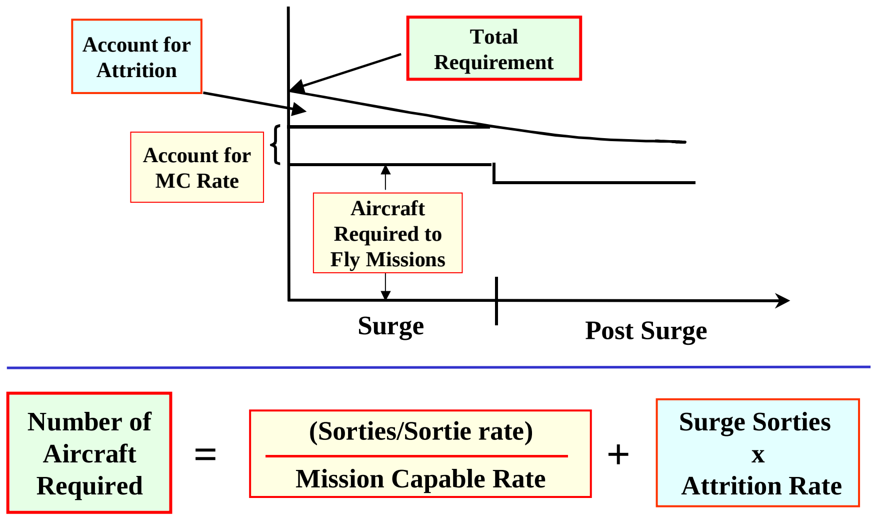


Table 8. Aircraft availability, sortie rates, and combat attrition[a]

Aircraft type	Aircraft availability	Surge sorties per aircraft per day: 1 hr mission	2 hr mission	3 hr mission
MV-22	.80	4.0	3.2	2.7
CH-53E	.70	4.0	3.2	2.7
AH-1Z	.75	4.0	3.2	2.7
UH-1Y	.75	4.0	3.2	2.7
JSF	.85	4.0	3.2	2.7
AEA	.85	4.0	3.2	2.7
KC-130J	.75	N/A	N/A	2.0
VTUAV	N/A	N/A	N/A	1.3

a. Surge attrition rates (first seven days): .25 per 100 sorties for JSF; .5 per 100 sorties for all others. Sustained rates (next eight days) are one half of the surge rates.

Except JSF, sortie rates for 1-hour missions were taken from the MSTP MEF Planners Reference Manual. The JSF value is taken from the ORD for a 1.1-hour mission. Values for the 2- and 3-hour missions were calculated by assuming that ground time would be roughly the same as for the 1-hour missions. With few exceptions, we did not use the sortie rates for 1-hour missions in our calculations. We used a rate of 3.2 sorties per available aircraft per day for most missions during the seven-day surge period. This is a higher sortie rate than was typically used in the 1989 study, and higher than historical data would support; therefore it anticipates better aircraft performance in the future. As such, we will be under-estimating the requirements if these rates cannot be achieved. We assumed a rate of two sorties per available aircraft per day for the eight-day sustained period.

For all aircraft other than JSF we used a combat attrition rate of 0.5 per 100 sorties for the first seven days and .25 per 100 sorties beyond seven days. This attrition rate was taken from service inputs to the Navy Non-Nuclear Ordnance Requirement (NNOR) process. We assumed that JSF values would likely be half or possibly better, and we used a rate of 0.25 per 100 sorties for the first seven days and .125 per 100 sorties beyond seven days. Calculations for our MTW analysis covered 15 days. The analysis process is straightforward enough that these numbers can be readily adjusted and excursions will be relatively easy to do.

Six functions of Marine aviation

Figure 4 lists the functions of Marine aviation. We organized our analysis around these functions.

Figure 4. Six functions of Marine aviation

The Six Functions of Marine Aviation

- **Assault support**
  - — Combat assault transport
  - — Air delivery
  - — Aerial refueling
  - — Air evacuation
  - — TRAP
  - — Air logistics support
  - — Battlefield illumination
- **Air reconnaissance**
  - — Visual
  - — Multi-sensor imagery
  - — Electronic
- **Electronic warfare**
  - — Electronic attack (EA)
  - — Electronic protection (EP)
  - — Electronic warfare support (ES)
- **Offensive air support**
  - — Close air support (CAS)
  - — Deep air support (DAS)
    - Air interdiction
    - Armed reconnaissance
- **Antiair warfare**
  - — Offensive (OAAW)
  - — Air defense
    - Active
    - Passive
- **Control of aircraft and missiles**
  - — Air direction
  - — Air control
    - Airspace management
    - Airspace control

MTW scenario analysis

This section summarizes our analysis of the MTW scenario. We present an overview of the scenario itself, a summary of the results, and summaries of the rotor-wing and fixed-wing results. Finally, we include some excursions and sensitivity analysis results that address issues that arose during the study.

Scenario overview

The base scenario was developed by MCIA and is a 2015 variation of the Defense Planning Guidance (DPG) RT-2. The scenario was initially fleshed out during a series of Blue Team meetings held early on in the study. Final details were added from further DPG research, Desert Shield/Desert Storm (DS/DS) historical data and consultation with SMEs.

The scenario concerns the invasion of a U. S. ally by a hostile nation. In the MTW scenario, enemy forces have advanced to a point where they have taken up defensive positions in an attempt to hold onto territory taken during their initial attacks. The mission of U.S. forces is to restore pre-invasion borders.

U. S. forces deploy and begin build-up as part of Flexible Deterrent Options (FDOs). Timing of the build-up and shaping phase is based upon review of the DPGs, DS/DS historical data, and other pertinent sources. Naval forces, including CVNs, DD-21s, DDGs, and CGs provide Naval Surface Fire Support (NSFS), naval tactical air (TACAIR) support and maritime superiority operations while the Army and Air Force focus on a different part of the area. All U. S. air forces participate in the numerous shaping operations in preparation for the counter offensive. Because the purpose of the study is to develop USMC aviation requirements, Joint actions are considered only in the broadest context.

USMC forces consist of one land-based MEF, one sea-based MEF, and an independent MEU. The land-based MEF is composed of two mechanized regiments and an air-mobile regiment. The sea-based MEF is composed of a surface regimental landing team, an air-mobile regimental landing team, and a regimental landing team in reserve that is positioned on amphibious and MPF(F) shipping.

The ground forces opposing the MAGTF include two group armies in direct contact, a group army in reserve, and an independent division. The enemy has a credible air threat of about 1,000 aircraft, a modern integrated air defense system (IADS) and surface-to-air missile (SAM) capability, anti-shipping cruise missiles, tactical ballistic missiles, and C4ISR capabilities to support theater operations.

Summary of MTW results

Table 9 summarizes the results of our MTW scenario analysis. For each aircraft and mission category, it shows the peak daily sorties and total sorties over the 15-day period. This formed the basis for determining the number of aircraft needed to fly the missions (peak daily sorties divided by the appropriate surge sortie rate). Total requirements were then determined by adding the numbers of additional aircraft needed to account for aircraft availability ("down" aircraft that are not available to fly), and expected losses to combat attrition. The total numbers therefore account for enough aircraft to carry through an initial surge period as well as the remainder of the conflict.

Rotor-wing functions and missions

In this category, we included MTW requirements for MV-22, CH-53E, AH-1Z, UH-1Y, and VTUAVs.

MV-22 and CH-53E requirements are driven by requirements to move forces ship-to-shore and around the battlefield. In the MTW scenario, independent MV-22 and CH-53E forces are needed to move one regimental landing team (RLT) ship-to-shore and then periodically from one location to another; periodically move another shore-based air

Table 9. Summarized aircraft requirements

Aircraft	Element	Peak Sorties Flown	Surge Sortie Rate	Total Sorties	Aircraft required: to fly sorties	for availability	for attrition	Total Aircraft
MV-22	AIR-RLT unit movement	264	3.5	2028	76	20	8	104
	AIR-TF unit movement	264	3.5	2056	76	20	8	104
	AIR-RES unit movement	71	2.0	497	36	9	2	47
	Other support[a]			1124			5	5
	Subtotal	**599**		**5705**	**188**	**49**	**23**	**260**
CH-53	AIR-RLT unit movement	124	3.4	917	36	16	4	56
	AIR-TF unit movement	124	3.4	960	36	16	4	56
	AIR-RES unit movement	27	2.3	189	12	6	1	19
	Other support[a]			411			2	2
	Subtotal	**275**		**2477**	**84**	**38**	**11**	**133**
AH-1Z	Attached escort/EFL/FAC(A)	184	3.2	1240	57	20	5	82
	Detached escort/FP	121	3.2	923	38	13	4	55
	Recon insert/extract	27	3.2	198	9	3	0	12
	CAS	94	3.2	1168	29	5	5	43
	Subtotal	**426**		**3529**	**133**	**45**	**14**	**192**
UH-1Y	MEDEVAC	44	3.2	475	14	5	2	21
	C2	57	3.2	684	19	7	3	29
	Recon	30	3.2	198	10	4	0	14
	FAC(A)	32	3.2	480	10	4	2	16
	Subtotal	**164**		**1837**	**53**	**20**	**7**	**80**
VTUAV	GCE support	16		240	12	n/a	1	13
	Dedicated ISR	12		180	9	n/a	1	10
	C2 Comm relay	16		240	12	n/a	1	13
	Subtotal	**44**		**660**	**33**		**3**	**36**
JSF	CAS	425	3.2	5103	133	23	10	166
	DAS	145	3.2	1751	46	8	3	57
	Air Defense	120	2.7	1544	44	8	3	55
	TAC(A)/FAC(A)/SCAR	32	3.2	384	10	2	1	13
	Assault Transport Escort	32	3.3	384	10	2	1	13
	Recon & Surveil	11	3.2	125	3	1	0	4
	Subtotal	**765**		**9291**	**246**	**44**	**18**	**308**
AEA	DAS Escort	18	3.2	222	6	2	1	9
	Sector coverage - helo	12	3.2	148	4	1	1	6
	Sector coverage - general	32	3.2	384	10	3	2	15
	Subtotal	**62**		**754**	**20**	**6**	**4**	**30**
KC-130J	Airborne DASC	4	2.0	60	2	1	0	3
	Aerial Refueling	41	2.0	623	21	7	2	30
	Subtotal	**45**		**683**	**23**	**8**	**2**	**33**

a. Other support includes MAGTF logistics support, reconnaissance insert/extract, and MEDEVAC). The sorties indicated are flown by the same aircraft that fly the unit movement sorties.

mobile regiment; and periodically move a reserve battalion. This degree of mobility requires a total of 260 MV-22s and 133 CH-53Es. Additionally we performed detailed analyses of the requirements for reconnaissance team inserts/extractions, medical evacuation (MEDEVAC), forward area refueling points (FARPs), and resupply missions. We found that if enough aircraft are available to meet the task forces' movement requirements, they can perform these other missions as well.

Approximately 192 AH-1Zs are required to meet sortie requirements for escort of CH-53Es during air assault operations, CAS, escort of reconnaissance team inserts/extractions, FAC(A), and area coverage around task force positions.

UH-1Y (80 aircraft) requirements include sorties for MEDEVAC and FAC(A) as well as C2 support and escort of reconnaissance team inserts/extractions.

VTUAV coverage is needed to support task force battlefield surveillance and targeting; fly general tactical intelligence, surveillance, and reconnaissance (ISR) missions in the MAGTF area of responsibility (AOR); and provide communications relay in the AOR. This requires approximately 36 Aerial Vehicles (AVs).

Fixed-wing functions and missions

Fixed-wing results include requirements for JSF, AEA, and KC-130J aircraft. CAS sorties are the primary driver for JSF sorties, followed by DAS and AAW. Other requirements include aircraft for TAC(A), strike coordination and reconnaissance (SCAR), FAC(A), AR, and general ISR sorties. JSF is intended to replace today's F/A-18 and AV-8B aircraft, flying missions across most functions of Marine aviation. To meet the MTW requirement, 308 JSF are needed.

Sortie requirements for AEA aircraft are primarily in support of DAS strikes, sector support for the assault support missions, and general support for the overall MAGTF AOR. We estimated a requirement for at least 30 AEA aircraft.

KC-130J sorties and aircraft requirements are driven by aerial refueling and Airborne Direct Air Support Center (DASC) missions. Specific requirements for refueling MV-22s were not included in this analysis. Further analysis with respect to additional demands on the KC-130J as a result of MV-22 will need to be examined, including self-deployment of MV-22s into theater.

Our analysis only accounts for MAGTF requirements. If additional aircraft are needed to support other forces in theater, then even more aircraft will be needed to meet future MTW requirements.

MTW excursions and sensitivity analyses

As previously mentioned, we examined the relative benefit of a modernized CH-53E that can lift LAVs and prime movers for the light weight 155-mm Howitzers under the temperature/altitude conditions considered in this study, and we performed a sensitivity analysis of our baseline calculations of the CAS requirement for JSF.

Modernized CH-53E

In our analysis, the aircraft must be able to operate at 3,000 ft MSL/ 91.5 deg F, based on requirements included in the MV-22 ORD. Under these conditions, the MV-22 and CH-53E lift a maximum of 9,000 and 12,000 pounds, respectively, at the ship-to-shore distance of 85 NM used in this analysis.

The Baseline RLT lift used in this analysis does not include lifting the prime movers (MVTRs) for the light weight 155-mm artillery or any LAVs. This limits the tactical effectiveness and versatility of the air assault forces. Indeed, the original CH-53E requirements called for the capability to lift the artillery prime movers and LAVs, but over a shorter distance at sea level on a standard day (59 deg F). The CH-53E could perform the required lift under these conditions. The requirements for 2015 call for a more versatile and robust maneuver capability in an expanded battlespace, and under the 3,000 ft MSL/ 91.5 deg F conditions.

Thus, the requirement remains to move MTVRs and LAVs by air in this environment. The CH-53E modernization initiatives are designed to meet such needs. On the one hand, the prime movers and LAVs are add-on requirements to our baseline lifts. On the other hand, the modernized CH-53E will enable the Marine Corps to lift two high-mobility multi-purpose wheeled vehicles (HMMWVs) at a time. As an excursion in this analysis, we looked at the difference that would make in terms of moving the RLTs.

Table 10 shows the results from this excursion. Using the same numbers of aircraft, the MV-22/CH-53E Mod mix can perform the Baseline RLT movement in significantly fewer sorties, fewer waves, and less time (compare first and second rows of the table). Note that we are using fractions of waves to give an idea of what fraction of the force is needed to finish that last wave. Thus “2.6 waves” indicates that 60 percent of the aircraft are needed to complete the third wave. This mix can also lift the Baseline RLT plus 25 LAVs, 18 MTVRs, and another 142 troops in about same time, slightly fewer waves, and fewer sorties than the Baseline (see third row of table). The key factors making this possible are increased lift capability (over 32,000 pounds) and the capability to lift two HMMWVs at the same time.

Table 10. Modernized CH-53E results

Lift Option: baseline RLT	MV-22 Internal Lifts	External lifts: MV-22	External lifts: CH-53E	External lifts: Mod CH-53E	Total Lifts	No. Waves	Time (hours)
CH-53E	141	123	124	n/a	388	3.5	3.4
Modernized CH-53E	131	61	n/a	100	292	2.6	2.9
Modernized CH-53E - baseline RLT plus: 25 LAVs, 18 MTVRs, 142 more troops	95	138	n/a	117[a]	350	3.2	3.4

a. 9 sorties are internal lifts

CAS requirement sensitivity analysis

We performed a sensitivity analysis of our fixed-wing CAS sortie calculation, in order to examine the importance of our assumptions about desired probability of destruction and weapon delivery effectiveness. Our baseline calculation assumed that 10 percent of all battlefield targets would be addressed per day; that sufficient target probability of damge (Pd) was 0.9; and that ordnance functioned properly and was delivered to the right target with the basic weapon accuracy 100 percent of the time ("weapon factor" Pw = 1).

In our sensitivity analysis, we varied several parameters. The percent of targets to be addressed per day was varied from the baseline of 10 percent to cases of 8 percent and 12 percent per day. We recalculated sortie totals using Pd values of 0.7, 0.8, and 0.9. We also varied the "weapon factor," Pw.

Pw affects the single shot (pass) probability of damage (SSPD) by accounting for the probability of all things functioning correctly between launch of the aircraft and the final moment when the weapon guides toward and explodes on or near the intended target. This incorporates the potential for the pilot to fail to acquire the target; for ordnance to fail to release, or fail to guide; or for several other complications to occur that could result in a "complete miss" and force the launch of additional sorties. For our sensitivity analysis, we calculated sorties required if Pw fell from a perfect 1.0 rate to a more conservative 0.8 rate. Data that are now available from recent real-world operations using PGMs indicate that a Pw of 1.0 is overly optimistic.

The results of the sensitivity analysis are summarized in figure 5 and table 11. Our baseline results in which Pw = 1.0 and Pd = 0.9 are highlighted. Also, the bottom rows of table 11 show the average target kills per sortie for the precision guided munition (PGM) and unguided munition (UM) sorties for the different values assumed for Pw and Pd. These are defined in detail in [1].

Figure 5. CAS sensitivity analysis

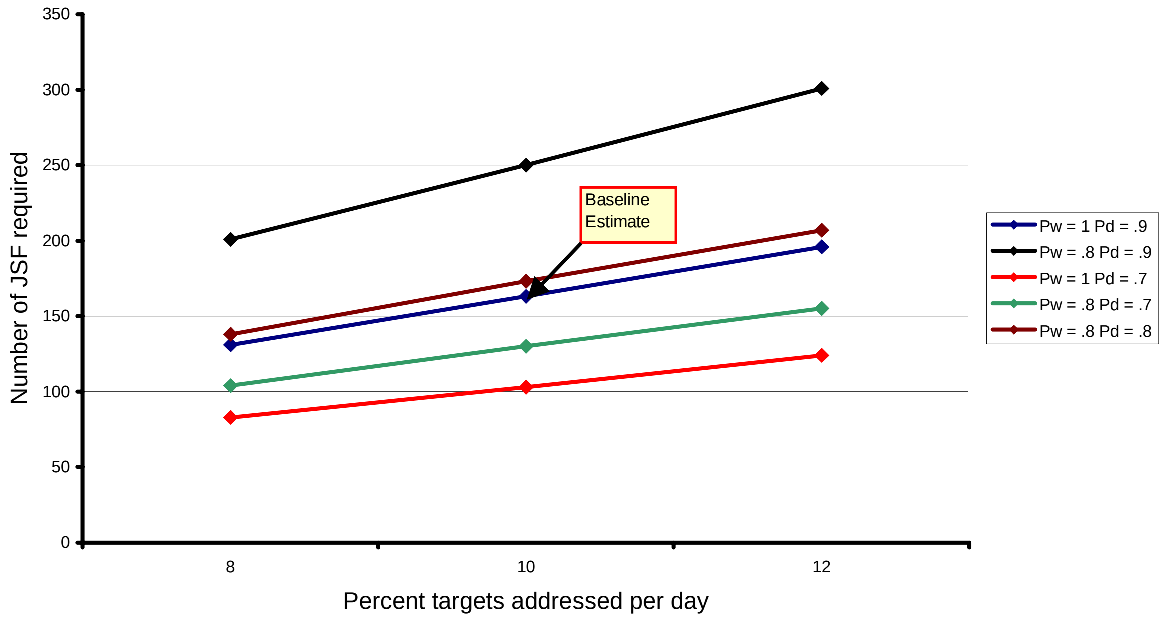


Table 11. CAS sensitivity analysis

Percent of targets addressed daily	Number of targets per day	Number of JSF aircraft required				
		Pw =1 Pd = .9	Pw = .8 Pd = .9	Pw = 1 Pd = .7	Pw = .8 Pd = .7	Pw = .8 Pd = .8
8	294	131	201	83	104	138
10	368	163	250	103	130	173
12	442	196	301	124	155	207
Average target kills per PGM sortie (Rg)		1.00	0.65	1.58	1.26	0.95
Average target kills per UM sortie (Ru)		0.40	0.28	0.69	0.53	0.40

Changes in the percentage of targets addressed daily result in a linear change in the number of sorties and number of aircraft as can be observed in figure 5, but results from changes in Pd or Pw are not linear. Notice in figure 5 that Pd = 0.8 and Pw = 0.8 produced results slightly higher than our baseline numbers, which tend to fall below the center of the values considered. Based on our discussions with SMEs and review of recent Pw data (indicating that current Pw may be as low as 0.6), we chose to retain our baseline estimates. These values of 10 percent of the targets, Pd = 0.9, and Pw = 1.0 are consistent with the 1989 study. Values of 10 percent of the targets, Pd = 0.8, and Pw = 0.8, are perhaps more consistent with recent operational data and suggestions by some that a Pd of 0.9 is perhaps too high. Interestingly, a case could be made for almost all of the choices in figure 5 and table 11. These estimates are clearly sensitive to the variables we examined, producing a significant variation in results. Our choice is near the center of the sensitivity analysis results, giving a relatively balanced estimate of the number of sorties required for fixed-wing CAS in our scenario.

SSC scenario analysis

This section summarizes our analysis of the SSC scenario. We begin with an overview of the scenario itself and then present a summary of the required numbers of rotor-wing and fixed-wing aircraft determined in the analysis.

Scenario overview

The base SSC scenario was taken from Dynamic Commitment Vignette #45. Classified references were removed to allow wider dissemination of the final product. Because Dynamic Commitment only gives the background and initial events of each vignette, follow-on details, to include time lines, were developed by the study team. In all cases, follow-on details were made to conform with the original intent of the scenario. No follow-on details for other service involvement are included.

The scenario involves a peace enforcement mission on a fictitious island partitioned into two separate countries, and separated by a UN-monitored buffer zone. Both countries are supported by larger foreign powers: one by a country 40 n.mi. to the north and the other by a country 300 n.mi. to the west. The scenario begins when one country launches an air strike against a port of the other. In an effort to stop the conflict from expanding, the United Nations requests NATO support to patrol the UN buffer zone, as well as enforce a no-fly zone that includes the entire island and a buffer zone of 25 miles. The U.S. agrees to send forces to the island in support of the NATO mission. Marine Corps forces will operate as part of a U.S. led Joint Task Force.

One country has a lightly armed National Guard that numbers approximately 20,000. In support are two infantry divisions and one armored brigade, numbering 30,000 troops, from the larger foreign power supporting the country.

The other country also has a lightly armed National Guard, numbering approximately 10,000. It is supported by a mechanized brigade of 2,500 troops from its supporting larger foreign power.

The main threat to U.S. forces is getting caught in a cross-fire between the various forces on the island. A secondary threat is the escalation of the conflict through the introduction of more forces from the larger foreign supporting powers.

The other services agree to send one Navy CVBG, one Air Force expeditionary air wing, and one Army Airborne Infantry Brigade (Rein). USMC forces include one MEU(SOC), one MPSRON, and one MPF MEB.

The USMC mission is to deter hostilities, enforce a peaceful environment, and support eventual transition to a peacekeeping action. In addition, the MEB is to establish refugee food distribution centers, and will supply required support for these centers. Estimated mission length is 6 months. The MEB ACE assists in enforcement of the no-fly zone, and is prepared to provide appropriate support in the event the situation escalates to actual combat.

Summary of results

Table 12 summarizes the results of our SSC scenario analysis. For each aircraft considered in the study, it shows the peak daily sorties. This forms the basis for determining the number of aircraft needed to fly the missions (peak daily sorties divided by the appropriate surge sortie rate). Total requirements are then determined by adding the numbers of additional aircraft needed to account for aircraft availability ("down" aircraft that are not available to fly). We do not anticipate losses due to combat attrition. The total numbers therefore account for enough aircraft to carry through an initial surge period as well as the remainder of the operation.

Table 12. Summarized aircraft requirements

Aircraft	Element	Peak sorties flown	Sortie rate	Aircraft required: to fly sorties	Aircraft required: for availability	Total aircraft
MV-22	MEU movement[a]	28	2.3	12	3	15
	MEB movement[a]	89	2.5	36	9	45
	Subtotal	**117**		**48**	**12**	**60**
CH-53	MEU movement[a]	11	2.8	4	2	6
	MEB movement[a]	34	2.8	16	7	23
	Subtotal	**45**		**20**	**9**	**29**
AH-1Z	MEU					
	- Attached escort	8	2.7	3	1	4
	- Detached escort	4	2.0	2	1	3
	MEB					
	- Attached escort/EFL	18	3.0	6	2	8
	- Detached escort	10	1.7	6	2	8
	Force protection	12	3.0	4	1	5
	Subtotal	**52**		**21**	**7**	**28**
UH-1Y	Command and control	9	3.0	3	1	4
	Recon escort	12	3.0	4	1	5
	Force protection	9	3.0	3	1	4
	Subtotal	**30**		**10**	**3**	**13**
VTUAV	Dedicated ISR	8		6	n/a	6
	Subtotal	**8**		**6**		**6**
JSF	CAS	72	4.0	18	3	21
	Air Defense	20	3.2	6	1	7
	TAC(A)/FAC(A)/SCAR	6	3.2	2	0	2
	Assault Transport Escort	10	3.3	3	1	4
	Recon & Surveil	24	3.2	8	1	9
	Subtotal	**132**		**37**	**6**	**43**
AEA	Sector coverage - general	16	3.2	5	1	6
	Subtotal	**16**		**5**	**1**	**6**
KC-130J	Air refueling	12	2.0	6	2	8
	Intra-theater logistics	2	2.0	1	0	1
	Subtotal	**14**		**7**	**2**	**9**

a. Movement sorties are combat assault transport sorties associated with "moving" the MEU and MEB ship-to-shore.

Rotor-wing functions and missions

In this category, we include SSC requirements for MV-22, CH-53E, AH-1Z, UH-1Y, and VTUAVs.

MV-22 and CH-53E requirements are driven by requirements to move some forces ashore and around the UN area of operations. In the SSC scenario, MV-22 and CH-53E sorties are needed to move MEU and MEB forces ship to shore, and periodically from one location to another once ashore. This degree of mobility requires a total of 60 MV-22 and 29 CH-53Es. Additionally we performed detailed analyses of the requirements for reconnaissance and re-supply missions. We found that if enough aircraft are available to meet movement requirements for the task force, they can perform these other missions as well.

Approximately 28 AH-1Zs are required to meet sortie requirements for escorting CH-53Es during combat assault support, escort, and force protection missions for the MEU and the MEB. Approximately 13 UH-1Y aircraft are also required, to meet combat assault transport of reconnaissance teams, command and control functions, and force protection of the MEU and MEB.

VTUAV coverage is needed to support general ISR missions in the MAGTF AOR. This requires approximately six aerial vehicles (AVs).

Fixed-wing functions and missions

Fixed-wing results include requirements for JSF, AEA, and KC-130J aircraft. CAS sorties are not required, but the MAGTF needs to be prepared to provide this capability if needed. In the current scenario, deep air support (DAS) is not required and sorties for this function of aviation have not been computed. Aircraft are needed for air defense (enforcement of the no-fly zone), TAC(A), SCAR, FAC(A), AR, and general ISR sorties. To meet the SSC requirement, 43 JSF are needed.

Sortie requirements for AEA aircraft are primarily needed for sector support for the assault support missions, and general support for the overall MAGTF AOR. We estimated a requirement for at least six AEA aircraft. These estimates do not reflect possible support to the other services.

KC-130J sorties are driven by aerial refueling needs and movement of equipment and supplies within the MAGTF AOR, and we estimate the requirement to be nine aircraft.

MEU scenario and ACE requirements

We developed MEU ACE requirements from an analysis of MEU missions and a MEU NEO scenario developed by the Marine Corps. We also examined the types of missions that different MEU ACE aircraft might be called upon to perform in support of the MEU.

Based on our initial look at the aviation requirements for various MEU missions, we felt that the best scenario to examine in detail was a NEO. In addition to being a very likely mission for a MEU, it is one of the most asset intensive. Depending on the particular situation, a NEO may call for security operations in addition to the evacuation of non-combatants.

Scenario overview

The scenario we examined in detail comes from the MV-22 COE. The COE was written with the input and direction of Warfighting Development Integration Division, Marine Corps Combat Development Command, and the Deputy Commandant for Aviation. It is based on real-world planning that was done by a MEU several years ago for an operation that was not executed.

The scenario is a long-range NEO in a country in the throes of a national rebellion, with the government controlling most urban centers and the rebels controlling most of the countryside. Although the government agrees to allow the United States to evacuate its citizens, it does not guarantee their safety. The MEU(SOC) must therefore be prepared to respond to a wide number of threats. Neighboring countries have also refused the United States fly-over rights and access to bases, thus requiring ship-to-objective maneuver (STOM) operations.

Enemy forces are mostly composed of rebel irregulars, armed with small arms, light machine guns, and rocket-propelled grenades. There are, however, some regular army units that have joined the rebellion as well, equipped with 20 to 24 tanks, 20 to 30 APCs and two batteries (12 tubes) of 122-mm Howitzers.

The ground threat, although minimal, does require the MEU to land with some anti-armor and long-range fire capability. The enemy air threat and anti-air threats are similarly unsophisticated, consisting of four to six operable light helicopters, eight to ten light attack aircraft, optically guided AAA, some SA-14s, and a few radar-guided surface-to-air missiles (SAMs).

Marines are inserted into four sites, with civilians to be evacuated from three of the sites. Marine forces are inserted to provide security and evacuation assistance.

Summary of results

Table 13 summarizes NEO aircraft requirements by number of sorties flown, minimum aircraft required, and number required when aircraft availability is taken into account. It also includes the current numbers of aircraft in a MEU.

Table 13. MEU ACE aircraft requirements for NEO

Aircraft	Sorties[a]	Minimum no. of aircraft required[b]	Aircraft availability	Aircraft required[c]	Current structure
MV-22	37	11	.80	14	12
CH-53E	12	4	.70	6	4
AH-1Z	16	4	.75	6	4
UH-1Y	6	2	.75	3	2
JSF	18	8	.85	10	6
KC-130	n/a	n/a	n/a	2	2
VTUAV	n/a	n/a	n/a	1 system	n/a

a. For transport helicopters, we count each cycle or round trip starting at the ARG as a sortie.
b. This is the maximum number of different aircraft airborne at the same time.
c. This takes aircraft availability into account. We divide the figure in the third column by the availability factor in the fourth column, and round up to the next whole number.

Rotor-wing functions and missions

A total of 14 MV-22s are needed: 3 to account for aircraft availability, and 11 to complete the NEO mission. Eleven aircraft can insert and extract the evacuation force and evacuate the non-combatants.

Six CH-53Es are required: two to account for aircraft availability, and four to insert and extract the reinforced rifle company (-) that serves as a blocking force. The same CH-53Es are also used to supplement the evacuation of civilians.

Six AH-1Zs are required: two to account for availability, and four used as attached escort for the CH-53E division and to provide detached escort/force protection for the MV-22 aircraft that extract civilians. The scenario requires a maximum of 4 AH-1Zs in the air at a given time.

Three UH-1Ys are needed: one is needed to insert and extract a reconnaissance team and monitor the situation on the ground. Because the operation occurs at night, another UH-1Y is required for airborne command and control, to provide CAS and force protection to a blocking force, as needed. The third UH-1Y is to account for availability.

MEU(SOC) air reconnaissance requirements fall into two types: reconnaissance of likely helicopter routes, beach landing zones, and helicopter landing zones; and more general area coverage. A section of JSF and one VTUAV system (which includes three aerial vehicles) can provide the necessary coverage.

Fixed-wing functions and missions

Ten JSF aircraft are needed: two to account for availability, and eight to conduct route reconnaissance, to provide continuous force protection for the MV-22s and reinforced rifle company, and to provide continuous force protection to a blocking force in the vicinity of one of the extraction points.

The MEU's two KC-130 stand-by detachments do not have a role in the NEO scenario. However, they do play an important role in some MEU missions, and should continue to be part of the MEU ACE.

Peacetime forward presence requirements

This section summarizes our analysis of Marine Corps peacetime squadron requirements. We based our peacetime squadron requirements analysis on current deployment and exercise support patterns of active force squadrons. We assume that these commitments, which define the peacetime operating tempo, will be about the same in the 2015 time frame. Reserve force structure is primarily driven by major theater war requirements.

We counted up the number of squadron equivalents that are required to conduct rotational deployments, by T/M/S aircraft. We multiplied those squadron-equivalents by a a factor of 3 or 4, depending on the T/M/S, to account for the rotation base needed to meet rotational deployment commitments continuously. We then added a number of squadron equivalents that typically are involved in supporting exercises that involve other forces—that is, exercises that are more than just a single squadron's training evolution.

Our focus is on rotational deployments, contingency operations, and support to ground forces. These activities are a sound basis for determining the number of squadrons required to accomplish peacetime operations.

Data sources

We compiled the activity of squadrons for the past 2 ½ fiscal years, and the planned activities for the next 2 ½ fiscal years. Our activity data are primarily from a Marine Corps deployment database being developed at CNA, which draws most of its information from Headquarters, Marine Corps operational summaries. We also obtained training exercise and employment plans (TEEPs) from the 1st, 2nd, and 3rd Marine Aircraft Wings (MAWs).

We organized the deployment and TEEP data by T/M/S, type of deployment, and deployment length rounded to nearest whole number of months. This allowed us to build a squadron deployment profile for each T/M/S for FY 1998-2002, which is the basis for determining peacetime requirements.

For those T/M/S that do not deploy as full squadrons, we used a fractional factor to create a squadron-equivalent deployment profile. For all T/M/S we used a fractional factor for exercise support to other forces and deployments for squadron training, because often these deployments are made by less-than-full squadrons. We used a different standard factor for each T/M/S (based on deployment practices), because our data did not always include information on how many aircraft were deployed on a particular exercise or how many are planned for a future exercise.

Peacetime squadron use

Table 14 summarizes the peacetime squadron usage data that we examined, summarizing usage data and the implied number of squadrons required to sustain a 3:1 and 4:1 rotation base. (A 3:1 rotation base means three squadrons are used to support one 6-month rotational deployment. That is, a squadron in this rotation is deployed for 6 months out of 18. A 4:1 rotation implies that a squadron is deployed for 6 months out of 24.) The second column of table 14 indicates the number of squadron equivalents that are deployed on rotational deployments (this includes MEU, UDP, CV, and longstanding rotational contingency deployments). The third column indicates the number of squadron equivalents typically deployed at any given time to support ground forces or higher headquarters-directed exercises.

The fourth column (3:1 requirements) is calculated by multiplying the deployed squadrons (second column) by 3 and adding the exercise squadrons (third column). The fifth column (4:1 requirement) is calculated by multiplying the deployed squadrons (second column) by 4 and adding the exercise squadrons (third column). These calculations provide the range of squadrons needed to provide the peacetime forward presence support on a continual basis.

Table 14. Summary of peacetime squadron requirements

	Squadron requirement			
Squadron type	Rotational deployments	Exercise support	Total: 3:1 rotation base[a]	Total: 4:1 rotation base[b]
HMM	3 - 4	2 - 3	11 - 15	14 - 19
HMH	1 1/2 - 1 3/4	1/2 - 1	5 - 6	7 - 8
HMLA	1 2/3 - 2	1/2 - 1	6 - 7	7 - 9
VMA	1 2/3 - 2	1 - 1 1/2	6 - 8	8 - 10
VMFA/VMFA(AW)	2 - 4	2 - 4	8 -16	10 - 20
VMAQ[c]	1 - 3	—	4	4
VMGR[d]	—	—	3	3

a. We multiplied the “rotational deployments” range by 3, added the “exercise support” range, and rounded to whole squadrons.
b. We multiplied the “rotational deployments” range by 4, added the “exercise support” range, and rounded to whole squadrons.
c. We did not carry out a calculation using a rotation base assumption. The current structure of four VMAQ squadrons is very heavily tasked with up to three squadrons deployed at times.
d. Our estimate of VMGR peacetime squadron activity is based on an analysis of flight hour activity, which suggests at least three squadrons are required to meet peacetime needs.

Transition to JSF

The JSF will replace three T/M/S aircraft: the AV-8B, the F/A-18C, and the F/A-18D. These are organized in 16-plane VMA, 12-plane VMFA, and 12-plane VMFA(AW) squadrons, respectively. Translating the VMA and VMFA/VMFA(AW) peacetime requirements into peacetime JSF squadron needs, requires several assumptions.

We assume that JSF squadrons will comprise 12 aircraft. Thus, the VMFA/VMFA(AW) translation to JSF is a straightforward one-for-one squadron replacement. This implies similar squadron deployment and exercise patterns.

The JSF squadron-for-VMA translation is trickier. Currently, VMA squadrons provide six-plane detachments to MEUs deploying from the east and west coasts of CONUS, as well as full-squadron UDP rotation to the 3rd MAW. We work out the translation for two cases.

First, assume a MEU will be supported with a six-plane JSF detachment—or half a JSF squadron. In this case, 2.0 to 2.5 squadrons are deployed and 1.0 to 1.5 are supporting exercises at any given time.

A 3:1 rotation implies 7 to 9 squadrons. Adding this to the VMFA/VMFA(AW) squadron numbers yields 15 to 25 JSF squadrons for the 3:1 rotation base assumed.

If we assume that MEUs will be supported with a full 12-plane JSF squadron, then 3 to 4 squadrons are deployed and 1.0 to 1.5 squadrons are supporting exercises at any given time. The 3:1 rotation implies 10 to 13 squadrons. Adding this to the VMFA/VMFA(AW) squadron numbers yields 18 to 29 JSF squadrons for a 3:1 rotation base.

Future peacetime squadron requirements

Table 14, above, summarizes the peacetime squadron requirements in terms of a range of squadrons. We also make point estimates of peacetime squadron requirements, which are summarized in table 15. For rotary-wing aircraft and the MV-22, we use the mid-point of the 4:1 rotation base range; we use the mid-point of the 3:1 rotation base for fixed-wing aircraft. These assumptions are similar to current practice. Peacetime JSF squadron requirements may be derived from peacetime VMA and VMFA/VMFA(AW) squadron requirements in several ways, using different assumptions, as presented above. The peacetime JSF squadron point estimate we report assumes a 12-plane JSF squadron and assumes an entire squadron supports each MEU deployment.

Table 15. Peacetime squadron requirement in 2015, by T/M/S

Squadron type	Aircraft	Peacetime requirement
VMM	MV-22	19[a]
HMH	CH-53E	6[a]
HMLA	AH-1Z, UH-1Y	8
JSF	JSF	24
VMAQ	EA-6B	4
VMGR	KC-130	3

a. HMH and HMM (CH-46E) requirements were estimated to be 17 and 8 squadrons, respectively. Because CH-53D HMH squadrons will be replaced by MV-22 VMM squadrons, the requirement was adjusted to obtain 19 MV-22 and 6 CH-53E squadrons.

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